PATENT
Docket No.: 04054

AFTER FINAL

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	:	
	:	
Brophy et al.	:	
	:	
Application No. 10/642,439	:	Art Unit: 1755
	:	
Filed: Aug 14, 2003	:	Examiner: James E. McDonough
	:	
For: TETHERED CATALYST PROCESSES	:	Conf. No. 2458
IN MICROCHANNEL REACTORS AND	:	
SYSTEMS CONTAINING A TETHERED	:	Atty Docket: 02-024
CATALYST OR TETHERED CATALYST	:	
AUXILIARY	:	

BRIEF ON APPEAL

Board of Patent Appeals and Interferences
Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

This Appeal Brief is submitted in accordance with the terms of 35 U.S.C. § 134 and 37 C.F.R. § 1.192 in response to the Final Office Action mailed July 22, 2009. The $270 small entity processing fee (37 C.F.R. § 41.20(b)(2)) is provided in documents accompanying this Brief; any fees required for consideration of this paper, which are not provided for in the accompanying documents, can be charged to deposit account 50-1749.

I. Real Party In Interest

Velocys Inc. headquartered in Plain City, Ohio, is the real party in interest.

II. Related Appeals and Interferences

None.

III. Status of Claims

Claims 1, 3, 5, 7-9, 11, 24, 28, 32, 34-43 and 45-53 are pending. Claims 1, 3, 5, 7-9, 11, 24, 28, 32, 34-43 and 45-53 have been rejected and are the subject of this appeal.

IV. Status of Amendments

The amendment filed May 30, 2008 was entered along with a Request for Continued Examination. The claims were not amended subsequent to the amendment filed May 30, 2008. A response that was filed by applicants on November 21, 2008 did not amend any claims; however, as stated in the Office Communication mailed December 5, 2008, this response (i.e., the response filed by applicants on November 21, 2008) was not entered.

V. Summary of the Claimed Subject Matter

The independent claims are 1, 8, 11 and 28.

Claim 1 recites a catalytic system comprising a tethered catalyst composition (page 6, lines 14-17) disposed in a microchannel, wherein the microchannel comprises a bulk flow path (page 8, lines 11-18), wherein the tethered catalyst composition comprises a solid support onto which has been immobilized an otherwise ordinarily molecular catalyst (page 6, lines 22-23) or procatalyst moiety (page 6, lines 20-21); and wherein the microchannel comprises at least one wall and wherein at least one heat transfer microchannel is adjacent to the at least one wall of the microchannel (Fig. 1, page 7, lines 18-20).

Claim 8 recites a catalytic system comprising a tethered catalyst composition (page 6, lines 14-17) disposed in a microchannel, wherein the microchannel comprises a bulk flow path (page 8, lines 11-18), wherein the tethered catalyst composition comprises a solid support onto which has been immobilized an otherwise ordinarily molecular catalyst (page 6, lines 22-23) or procatalyst moiety (page 6, lines 20-21); and wherein the microchannel comprises at least one wall and the tethered catalyst composition is coated on the wall of the microchannel; and tethered catalyst composition comprises a tether with at least a three atom chain.

Claim 11 recites a catalytic system comprising a tethered catalyst composition (page 6, lines 14-17) disposed in a microchannel, wherein the microchannel comprises a bulk flow path (page 8, lines 11-18), wherein the tethered catalyst composition comprises a solid support onto which has been immobilized an otherwise ordinarily molecular catalyst (page 6, lines 22-23) or procatalyst moiety (page 6, lines 20-21); and wherein the microchannel comprises at least one

wall and the tethered catalyst composition is coated on the wall of the microchannel; and further comprising a micromixer (page 13, lines 13-14) positioned to mix reactants prior to passage into the microchannel.

Claim 28 recites a catalytic system comprising a tethered catalyst composition (page 6, lines 14-17) disposed in a microchannel, wherein the tethered catalyst composition comprises a solid support onto which has been immobilized an otherwise ordinarily molecular catalyst (page 6, lines 22-23) or procatalyst moiety (page 6, lines 20-21); and wherein the microchannel comprises at least one wall and the tethered catalyst composition is coated on the wall of the microchannel; and wherein the microchannel comprises a chiral auxiliary (page 6, lines 24-25).

VI. Grounds Of Rejection To Be Reviewed On Appeal

1. Are claims 1, 3, 5, 7-9, 11, 24, 28, 32, 34-39, 41-42, 47 and 49-53 obvious in view of over Haswell et al., Lab on a Chip (2001), pp. 164-166 in view of Tonkovich et al. (U.S. Patent No. 6,488,838)?

2. Are claims 28, 32, and 41 obvious in view of over Haswell et al., Lab on a Chip (2001), pp. 164-166 in view of Tonkovich et al. (U.S. Patent No. 6,488,838) and further in view of Hoveyda et al. (U.S. Published Patent Application No. 2004/0019212)?

3. Is claim 40 obvious in view of over Haswell et al., Lab on a Chip (2001), pp. 164-166 in view of Tonkovich et al. (U.S. Patent No. 6,488,838) and further in view of Kang (U.S. Patent No. 3,993,855)?

4. Are claims 43, 45, and 48 obvious in view of over Haswell et al., Lab on a Chip (2001), pp. 164-166 in view of Tonkovich et al. (U.S. Patent No. 6,488,838) and further in view of Chapman, Jr. (U.S. Published Patent Application No. 2002/0182603)?

5. Is claim 46 obvious in view of over Haswell et al., Lab on a Chip (2001), pp. 164-166 in view of Tonkovich et al. (U.S. Patent No. 6,488,838) and further in view of Ostoja-Starzewski et al. (U.S. Published Patent Application No. 2003/0036474)?

VII. Argument

I. Claims 1, 3, 5, 7-9, 11, 24, 28, 32, 34-39, 41-42, 47 and 49-53 are not obvious in view of over Haswell et al., Lab on a Chip (2001), pp. 164-166 in view of Tonkovich et al. (U.S. Patent No. 6,488,838)

Haswell et al. describe an experiment in which a thin tube was packed with catalyst beads. See page 165 under the heading "Flow experiments." Haswell et al. made the catalyst beads by immobilizing a nickel complex onto resin beads. Haswell et al. reported reaction rates for the Kumada-Corriu reaction compared between the packed microchannel tube and a batch reactor. Haswell et al. reported that the reaction proceeded much faster in the microchannel as compared with the batch reaction. At the bottom of the second column of page 165, Haswell et al. teach away from a bulk flow path: "In the constraints of the microreactor, where the beads are packed in the capillary, the reactive solution is driven through the pores under pressure and the number of catalytic sites available for reaction is increased."

Tonkovich et al. describe the use of a microchannel reactor comprising a porous catalyst and a bulk flow path through the microchannel. The Tonkovich reference is also cited to show that a conventional way to accomplish heat transfer in a microchannel reactor is to arrange a heat transfer microchannel adjacent to the reaction channel.

A. It would not have been obvious to modify the Haswell system by replacing the packed bed with a bulk flow channel.

Independent claims 1, 8, and 11 all require a bulk flow path. Haswell et al. do not suggest a bulk flow path. As evidenced by the Tonkovich patent, the use of a microchannel containing a catalyst and a bulk flow path was known; however, there was no motivation to modify Haswell's reactor with a bulk flow path. Nor was it obvious to try this modification. To the contrary, Haswell et al. teach the importance of using a packed bed in a microchannel: "In the constraints

of the microreactor, where the beads are packed in the capillary, the reactive solution is driven through the pores under pressure and the number of catalytic sites available for reaction is increased." When inventors proceed in the opposite direction from that taught in the prior art, that is the antithesis of obviousness. See *In re Rosenberger* 386 F.2d 1015 (CCPA 1967) and *In re Buehler* 515 F.2d 1134, 185 USPQ 781 (CCPA 1975). In view of Haswell's teaching of a packed bed and the advantages of a packed bed, it would not have been obvious to do the opposite of what is taught and replace the packed bed with a bulk flow path and conduct a reaction over a tethered catalyst in a reactor with a bulk flow path.

B. The claimed invention is nonobvious in view of Applicants' showing of unexpected results.

The claims recite that the microchannel comprises a bulk flow path. Pages 17-19 of Applicants' specification describe an example of the inventive system for conducting the Knoevenagel reaction. On page 19, Applicants show that the use of a tethered catalyst in a microchannel having a bulk flow path produced superior results as compared to the same reaction in a packed microchannel. As stated on page 19, "These results demonstrate the significantly higher yields at much shorter residence times when this type of catalyst is tethered to the walls of a microchannel reactor compared to conventional packed bed or packed microreactors." Furthermore, the Declaration by Dr. Brophy shows a comparison of catalyst turnover rate (TOR) for a tethered catalyst on a channel wall adjacent a bulk flow path (the claimed invention) versus a tethered catalyst on beads packed in a microchannel. For the inventive configuration, the catalyst turnover rate (TOR) was an order of magnitude higher than the packed bed configuration (see paragraphs 2-5 of the attached Declaration).

The superior results observed from the inventive configuration is generally applicable. Both applicants and Haswell et al. used the Knoevenagel reaction to model the general case of using tethered catalysts in microchannel reactors. Both groups expected results from the Knoevenagel reaction to be generally applicable and there is no reason to believe that the Knoevenagel reaction is a special case. Indeed, as evidenced by paragraph 7 of the Declaration, Dr. Brophy, who is an expert in the field, believes that the observed improvement for a flow-by configuration versus a flow-through configuration, is generally true. Thus, the showing of unexpected results is commensurate in scope with the claimed invention.

The law on unexpected results is well established. "[W]hen the applicant demonstrates substantially improved results, . . . and states that the results are unexpected, this should suffice to establish unexpected results in the absence of evidence to the contrary." In re Soni, 54 F.3d 746, 750, 34 USPQ2d 1684, 1687 (Fed. Cir. 1995). Thus, applicants have established surprising and superior results as compared to the prior art (i.e., as compared to a packed microreactor as in the Haswell reference). In view of these unexpected results, applicants have established nonobviousness of the claimed invention.

On page 7 of the Final Office Action mailed July 22, 2008, the Examiner rejected Applicants' showing of unexpected results on the grounds that "Since the *combination* of references teach the use of a bulk flow path, it is not understood how these results are unexpected." (emphasis added). This is the wrong standard for determining unexpected results. MPEP §716.02(e).III clearly states that a showing of unexpected results should be compared against a single reference and it is improper to compare the showing of unexpected results against a combination of references.

Two ways to show that an invention is not obvious are "(1) [t]hat the prior art taught away from the claimed invention...or (2) that there are new and unexpected results relative to the

prior art.'" quoting *Iron Grip Barbell Co., Inc. v. USA Sports, Inc.*, 392 F.3d 1317, 1322, 73 USPQ2d 1225, 1228 (Fed. Cir. 2004). In this case, there is ample evidence of both a teaching away in the prior art, and of unexpected results. As noted above, in the cited Haswell reference, Haswell et al. teach that it is necessary to operate with high pressure to force solution through packed beads to obtain improved performance. In other words, Haswell et al. teach away from a reactor employing a bulk flow path. Contrary to Haswell's teaching that a packed microchannel is necessary for improved results, applicants discovered that superior results are obtained with a bulk flow path. There is no basis in the prior art to expect that tethered catalysts would have better catalyst turnover rates in a flow-by configuration as compared to flow through. Thus, applicants have established superior and unexpected results. See MPEP 716.02(a) Therefore, the rejection under section 103 must be withdrawn.

II. Claims 28, 32, and 41 are not obvious in view of over Haswell et al., Lab on a Chip (2001), pp. 164-166 in view of Tonkovich et al. (U.S. Patent No. 6,488,838) and further in view of Hoveyda et al. (U.S. Published Patent Application No. 2004/0019212)

A. Claims 28, 32, and 41 are Patentable

Claims 23 and 41 are dependent claims. Since the independent claims are patentable for the reasons described above in Part I, these dependent claims are also patentable.

Additionally, there isn't a proper motivation to combine these three references in the manner suggested.

B. Claim 28 is Separately Patentable

Claim 28 is an independent claim that requires a "chiral auxiliary."

First, as applicants have argued on pages 11-12 in the Amendment submitted May 30, 2008, Hoveyda does not qualify as prior art. Hoveyda was filed May 12, 2003. The present application claims the benefit of U.S. Patent Application Ser. No. 60/403,952 which was published on August 15, 2002. The invention of claim 28 is clearly supported at page 6, lines 20-28 of the '952 patent application. Accordingly, the rejection of claim 28 should be withdrawn.

Second, a catalytic system comprising microchannel containing a tethered catalyst and a chiral auxiliary is not obvious because Hoveyda et al. do not describe a chiral auxiliary. The Examiner has argued that a chiral auxiliary is the same thing as a chiral catalyst. Dr. Brophy in paragraph 8 of the Declaration states that a chiral auxiliary is not the same thing as a chiral catalyst. The Examiner has proffered no evidence as to the meaning of a chiral auxiliary except that on page 8 of the Final Office Action mailed July 22, 2008, the Examiner states that "based on the wikipedia definition of chiral auxiliary, a chiral auxiliary reads on a chiral auxiliary." The Examiner's argued definition for "chiral auxiliary" is not consistent with the accepted definitions of "chiral catalyst" and "chiral auxiliary" as evidenced by the definitions in Wikipedia. Chiral auxiliaries use steric hinderance to block the formation of one stereoisomer, see http://en.wikipedia.org/wiki/Chiral_auxiliary. On the other hand, chiral catalysts, which were introduced in 1968 by Knowles and Noyori, who were later awarded a Nobel Prize for their work, catalyze the reaction (i.e., lower the activation energy and thus increase the rate of formation of a desired stereoisomer). This distinction between chiral auxiliaries and chiral catalysts is explained at http://en.wikipedia.org/wiki/Asymmetric_synthesis. Thus, a chiral catalyst is not a chiral auxiliary; and, therefore, the cited references do not suggest a chiral auxiliary.

III. Claim 40 is not obvious over Haswell et al., Lab on a Chip (2001), pp. 164-166 in view of Tonkovich et al. (U.S. Patent No. 6,488,838) and further in view of Kang (U.S. Patent No. 3,993,855)

Claim 40 is a dependent claim. Since the independent claim is patentable for the reasons described above, the dependent claim is also patentable.

IV. Claim 43, 45, and 48 are not obvious over Haswell et al., Lab on a Chip (2001), pp. 164-166 in view of Tonkovich et al. (U.S. Patent No. 6,488,838) and further in view of Chapman, Jr. (U.S. Published Patent Application No. 2002/0182603)

Claims 43, 45, and 48 are dependent claims. Since the independent claims are patentable for the reasons described above, the dependent claims are also patentable.

V. Claim 46 is not obvious over Haswell et al., Lab on a Chip (2001), pp. 164-166 in view of Tonkovich et al. (U.S. Patent No. 6,488,838) and further in view of Ostoja-Starzewski et al. (U.S. Published Patent Application No. 2003/0036474)

Claim 46 is a dependent claim. Since the independent claim is patentable for the reasons described above, the dependent claim is also patentable.

Conclusion

For the foregoing reasons, appellants respectfully submit that the Examiner has erred in rejecting this application. Please reverse the rejections discussed above.

Dated this 23rd day of February, 2009.

Respectfully submitted,

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VII. CLAIMS APPENDIX

1. (previously presented) A catalytic system comprising a tethered catalyst composition disposed in a microchannel, wherein the microchannel comprises a bulk flow path, wherein the tethered catalyst composition comprises a solid support onto which has been immobilized an otherwise ordinarily molecular catalyst or procatalyst moiety; and

wherein the microchannel comprises at least one wall and wherein at least one heat transfer microchannel is adjacent to the at least one wall of the microchannel.

2. (canceled)

3. (previously presented) The catalytic system of claim 1 wherein the tethered catalyst composition is attached to at least one wall of the microchannel that defines the bulk flow path in the microchannel.

4. (canceled)

5. (original) The catalytic system of claim 1 wherein said tethered catalyst composition or tethered chiral auxiliary is provided as, or part of, a porous insert.

6. (canceled)

7. (previously presented) The catalytic system of claim 1, wherein said tethered catalyst composition comprises a solid support selected from the group consisting of: a solid inorganic oxide, carbon, an organic polymer, silica, alumina, a clay, a zeolite and a mesoporous solid.

8. (previously presented) A catalytic system comprising a tethered catalyst composition disposed in a microchannel, wherein the microchannel comprises a bulk flow path, wherein the tethered catalyst composition comprises a solid support onto which has been immobilized an otherwise ordinarily molecular catalyst or procatalyst moiety; and

wherein the microchannel comprises at least one wall and the tethered catalyst composition is coated on the wall of the microchannel; and

tethered catalyst composition comprises a tether with at least a three atom chain.

9. (previously presented) The catalytic system of claim 8, wherein the tethered catalyst composition comprises one or more member selected from the group consisting of a metal, a metal coordination complex, an organometallic complex, an oxidant, a reductant, an acid, and a base.

10. (canceled)

11. (previously presented) A catalytic system comprising a tethered catalyst composition disposed in a microchannel, wherein the microchannel comprises a bulk flow path, wherein the tethered catalyst composition comprises a solid support onto which has been immobilized an otherwise ordinarily molecular catalyst or procatalyst moiety; and

wherein the microchannel comprises at least one wall and the tethered catalyst composition is coated on the wall of the microchannel; and

further comprising a micromixer positioned to mix reactants prior to passage into the microchannel.

12-23. (canceled)

24. (original) The catalytic system of claim 1 wherein the microchannel comprises at least one wall and a tethered catalyst or a tethered chiral auxiliary is coated on the wall of the microchannel.

25-27. (canceled)

28. (previously presented) A catalytic system comprising a tethered catalyst composition disposed in a microchannel, wherein the tethered catalyst composition comprises a solid support onto which has been immobilized an otherwise ordinarily molecular catalyst or procatalyst moiety; and

wherein the microchannel comprises at least one wall and the tethered catalyst composition is coated on the wall of the microchannel; and

wherein the microchannel comprises a chiral auxiliary.

29-31. (canceled)

32. (previously presented) The catalytic system of claim 1, wherein the system comprises a tethered catalyst composition comprising a dendritic catalyst.

33. (canceled)

34. (previously presented) The catalytic system of claim 1 wherein the microchannel comprises a minimum dimension of greater than 1 μm and a length greater than 1 cm.

35. (previously presented) The catalytic system of claim 8, comprising at least one heat transfer microchannel that is adjacent to at least one wall of the microchannel.

36. (previously presented) The catalytic system of claim 35 wherein the at least one wall of the microchannel is comprised of an iron-containing alloy.

37. (previously presented) The catalytic system of claim 34 comprising at least 3 arrays of planar microchannels that comprise a tethered catalyst composition or a tethered chiral auxiliary disposed in the microchannels.

38. (previously presented) The catalytic system of claim 34 comprising at least 10 layers of heat exchangers interleaved with at least 10 layers comprising the microchannels that comprise a tethered catalyst composition or a tethered chiral auxiliary disposed in the microchannels.

39. (previously presented) The catalytic system of claim 34 comprising a bridging oxo group connecting a transition metal center of a tethered catalyst with a metal or semimetal on a surface of the interior of the microchannel.

40. (previously presented) The catalytic system of claim 1 wherein said tethered catalyst composition is made from an inorganic compound comprising $Ni[P(OMe)_3]_4$, $NiCl_2(PEt_3)_2$, $RhH(CO)(PPh_3)_3$, $RhCl(CO)(PPh_3)_2$, or $IrCl(CO)(PPh_3)_2$.

41. (previously presented) The catalytic system of claim 34 comprising at least 10 of the microchannels that comprise a tethered catalyst composition or a tethered chiral auxiliary disposed in the microchannel.

42. (previously presented) The catalytic system of claim 3 wherein the bulk flow path comprises a gap of 0.1 to 1.0 mm.

43. (previously presented) The catalytic system of claim 8 wherein the system comprises a tethered catalyst composition made by reacting $Cl\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}SiH_3$, $Cl\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}Si(OCH_3)_3$, or $Cl\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}NH_2$ with a support surface.

44. (canceled)

45. (previously presented) The catalytic system of claim 1 wherein the system comprises a tethered catalyst composition made by reacting a metal complex with a tether that is subsequently reacted with an inorganic support.

46. (previously presented) The catalytic system of claim 1 wherein the system comprises a tethered catalyst composition comprising a tethered metallocene.

47. (previously presented) The catalytic system of claim 1 wherein the system comprises a tethered catalyst composition comprising a Schiff base palladium catalyst.

48. (previously presented) The catalytic system of claim 47 wherein a surface is modified with an aminopropyl tether.

49. (previously presented) The catalytic system of claim 28 wherein the microchannel comprises a bulk flow path.

50. (previously presented) The catalytic system of claim 1 wherein the microchannel comprises a cross section, and wherein the bulk flow path comprises at least 50% of the cross section of the microchannel.

51. (previously presented) The catalytic system of claim 1 wherein the microchannel comprises a cross section, and wherein the bulk flow path comprises 30% to 80% of the cross section of the microchannel.

52. (previously presented) The catalytic system of claim 1 wherein the tethered catalyst is in the form of a porous material in which at least 50% of the material's pore volume is in the size range of 0.1 to 300 μm.

53. (previously presented) The catalytic system of claim 1 wherein tethered catalyst composition comprises an amino-modified silica.

VIII. EVIDENCE APPENDIX

1. Declaration of Dr. John H. Brophy. Entered into the record along with the Request for Continued Examination filed 30 May 2008.

2. U.S. Provisional Patent Application Serial No. 60/403,952. This is the parent provisional application and priority to this application was claimed in the original filing on August 14, 2003.

APPENDIX OF RELATED APPEALS AND INTERFERENCES

None.